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**Blaney**

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(54) **APPARATUS AND METHOD FOR TESTING MULTIPLE INTEGRATED CIRCUIT DEVICES ON A FILM FRAME HANDLER**

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(51) **Int. Cl.**
***G01R 31/26*** (2006.01)

(52) **U.S. Cl.**
USPC ..................................................... **324/762.01**

(58) **Field of Classification Search**
USPC ............... 324/754.01–754.3, 755.01–755.11, 324/762.01–762.1; 257/48; 438/14–18
See application file for complete search history.

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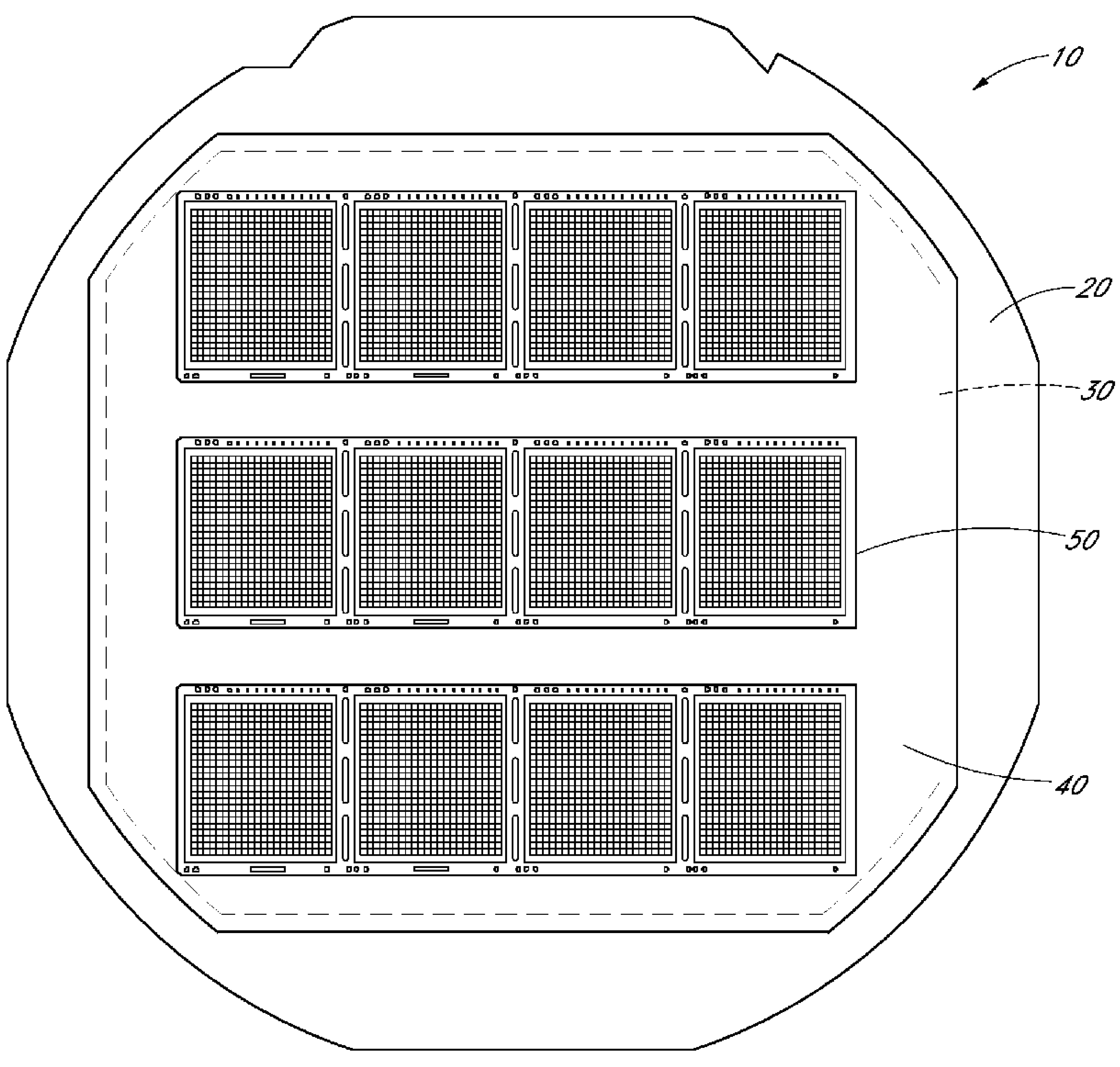
(57) **ABSTRACT**

Film frame assemblies and apparatus for testing and singulating integrated circuit packages, as well as associated methods for forming a film frame assembly, and testing and singulating integrated circuit packages are disclosed. A plurality of leads on a lead frame are cut to form singulated integrated circuit packages. Apparatus and methods are disclosed for mechanically aligning a set of electrical contacts attached to a contactor body with a plurality of leads on a singulated integrated circuit package.

**25 Claims, 10 Drawing Sheets**



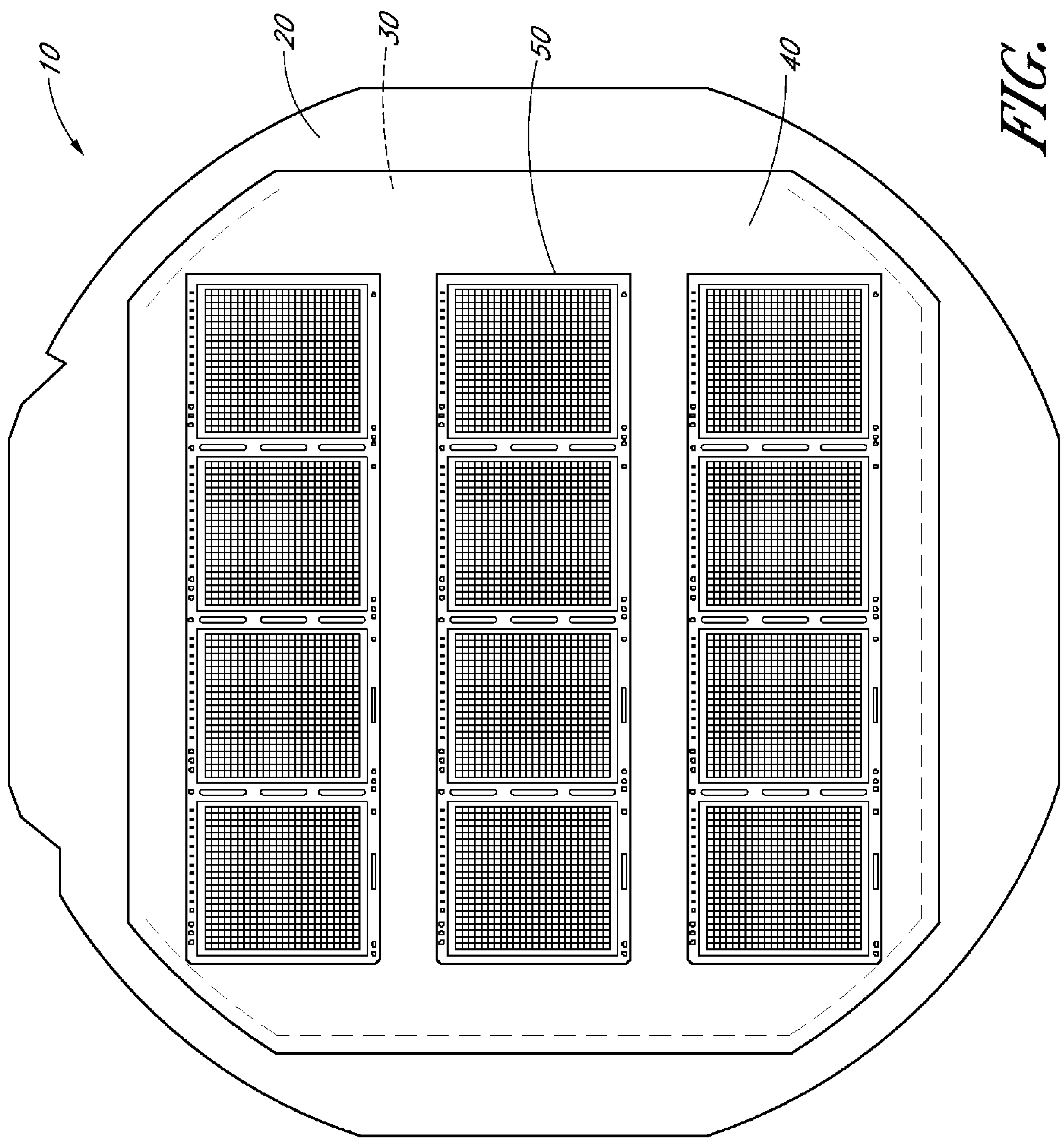



FIG. 1

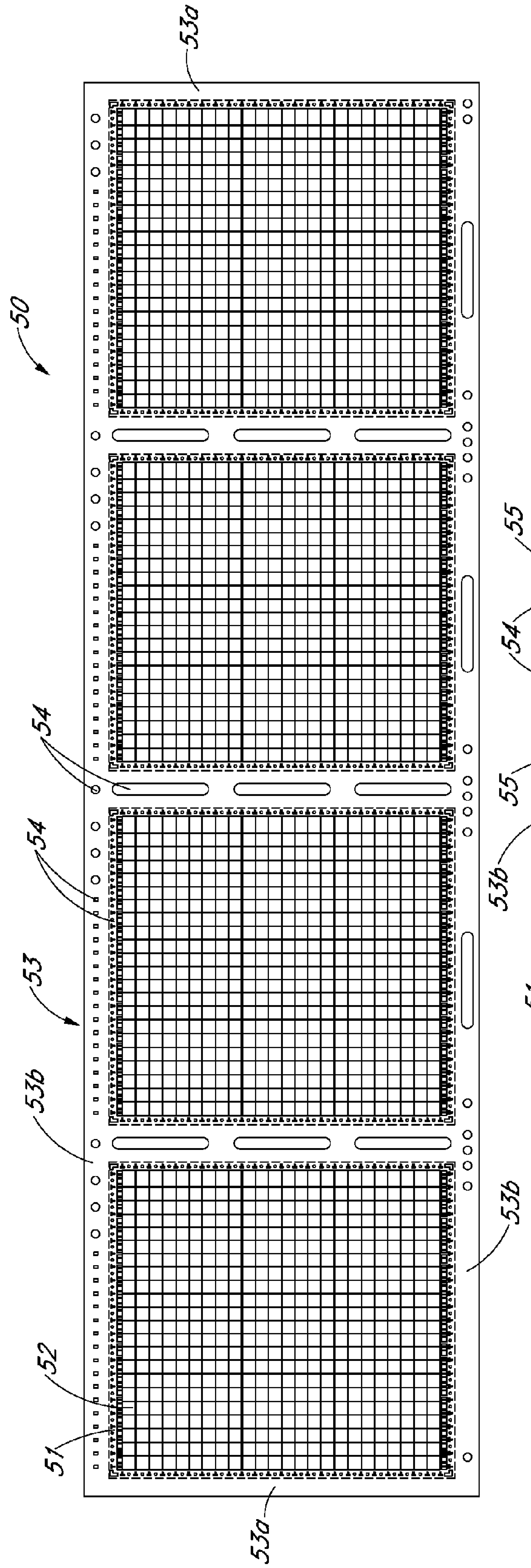

50
53a
54
54
53
53b
53b
52
51
53a

FIG. 2

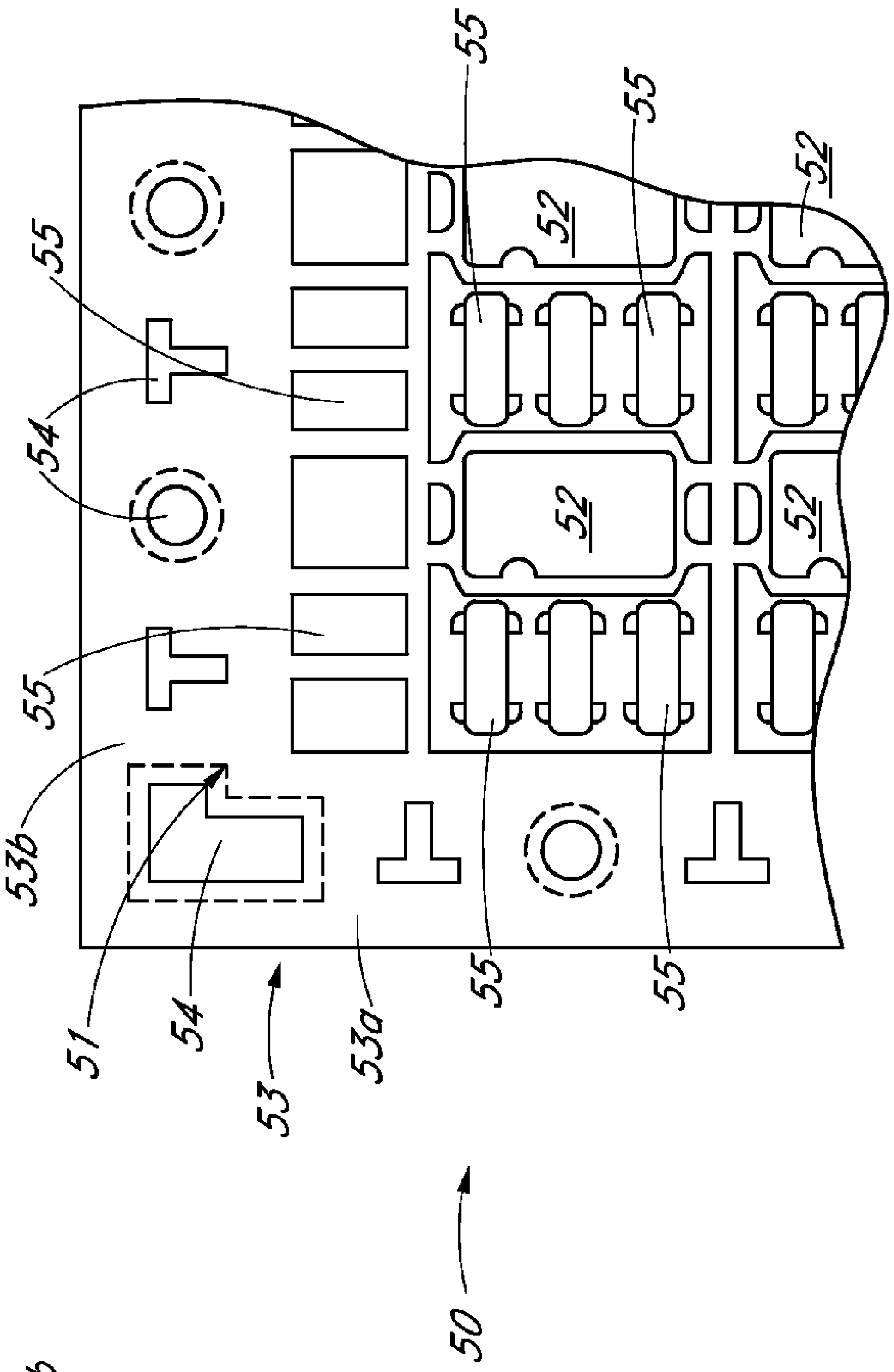

55
55
55
52
52
52
52
54
55
53b
51
54
53
53a
55
55
50

FIG. 4

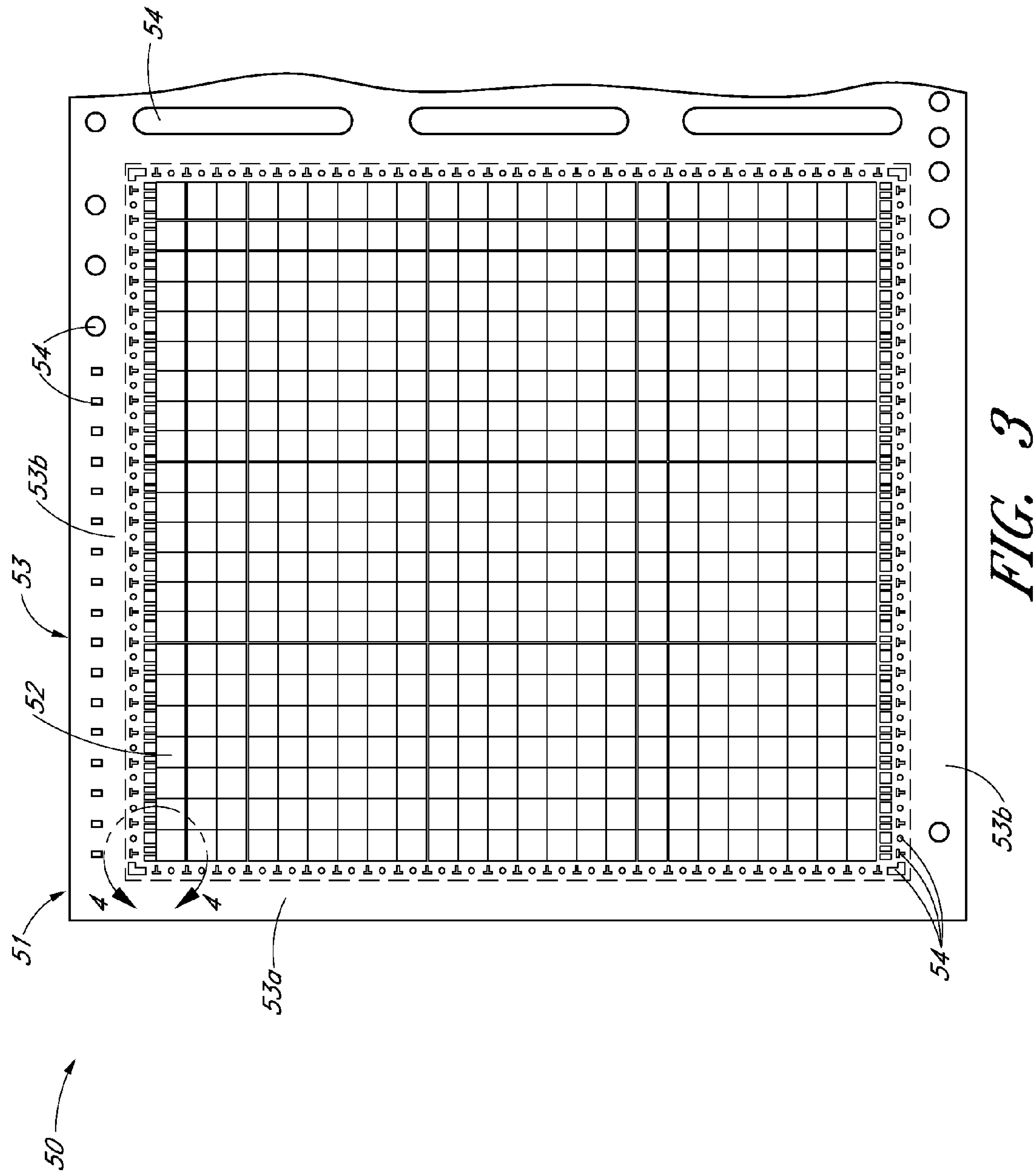



FIG. 3

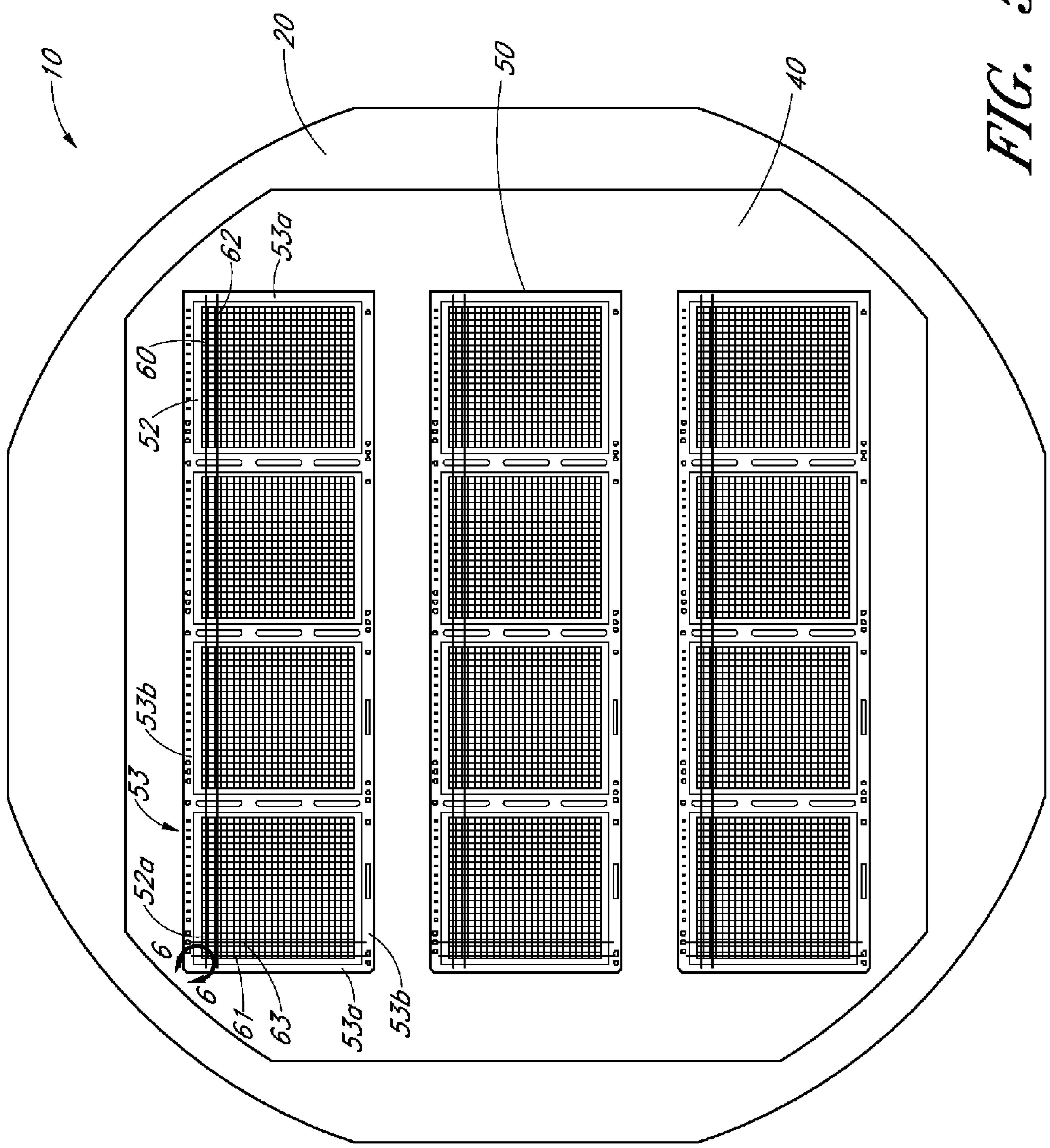



FIG. 5

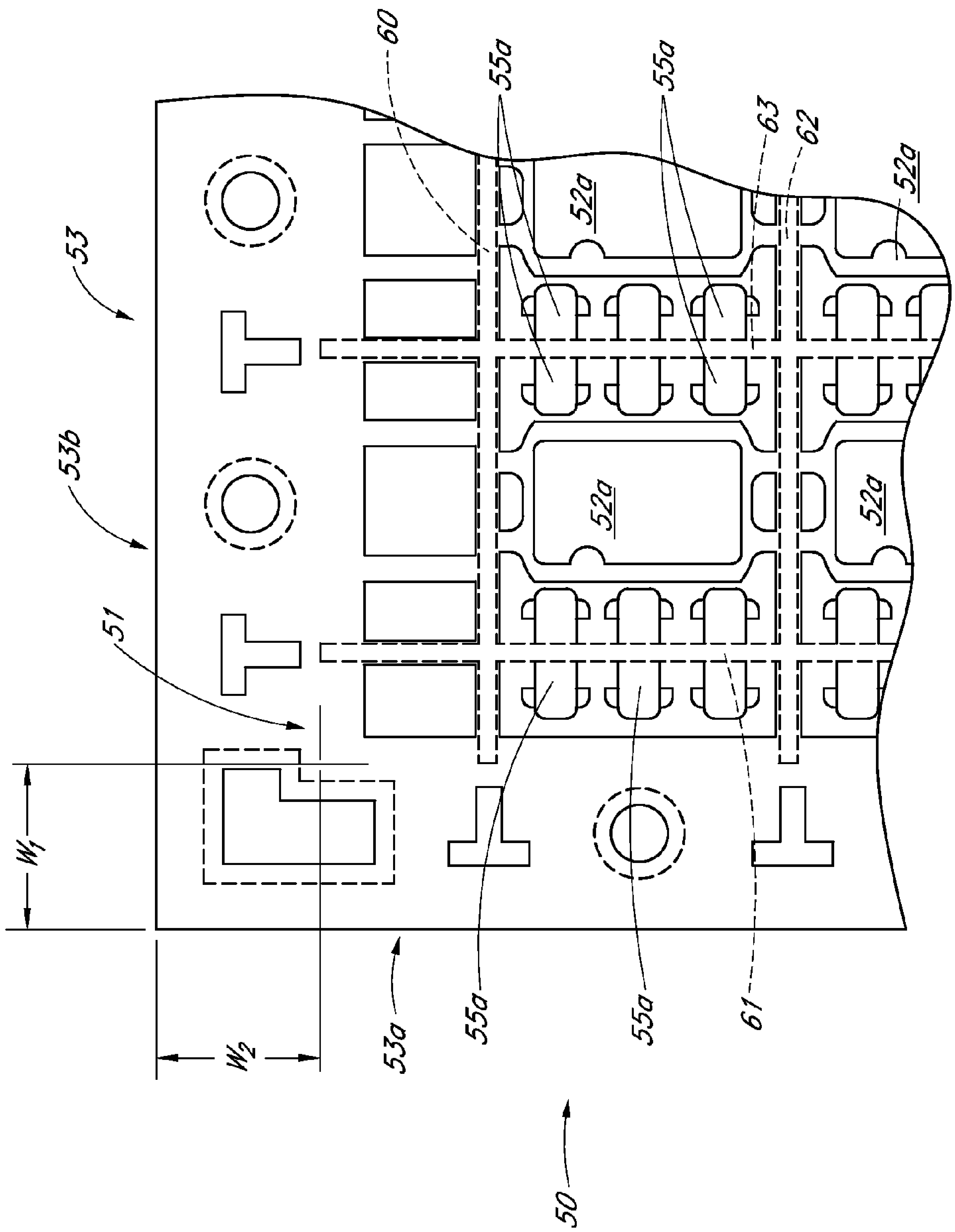



FIG. 6A

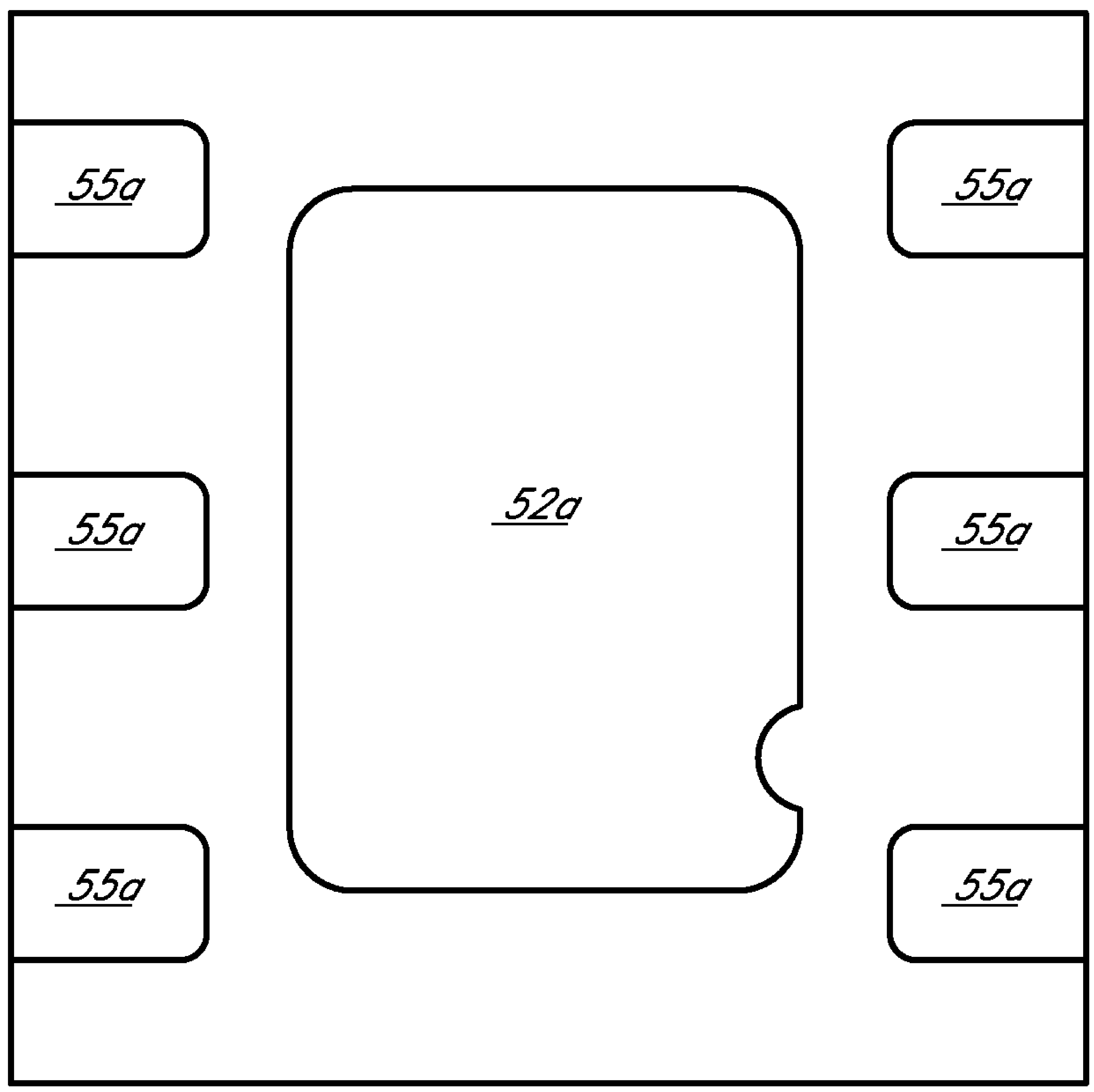



FIG. 6B

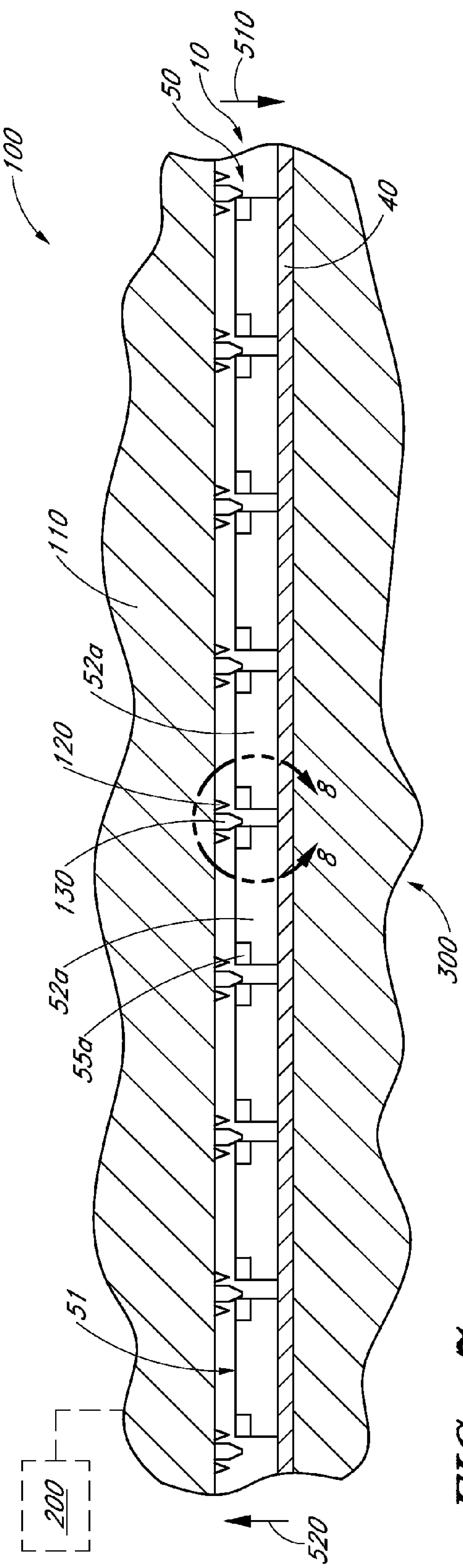

100
50
10
510
40
110
52a
120
130
8
8
52a
55a
300
51
200
520

FIG. 7

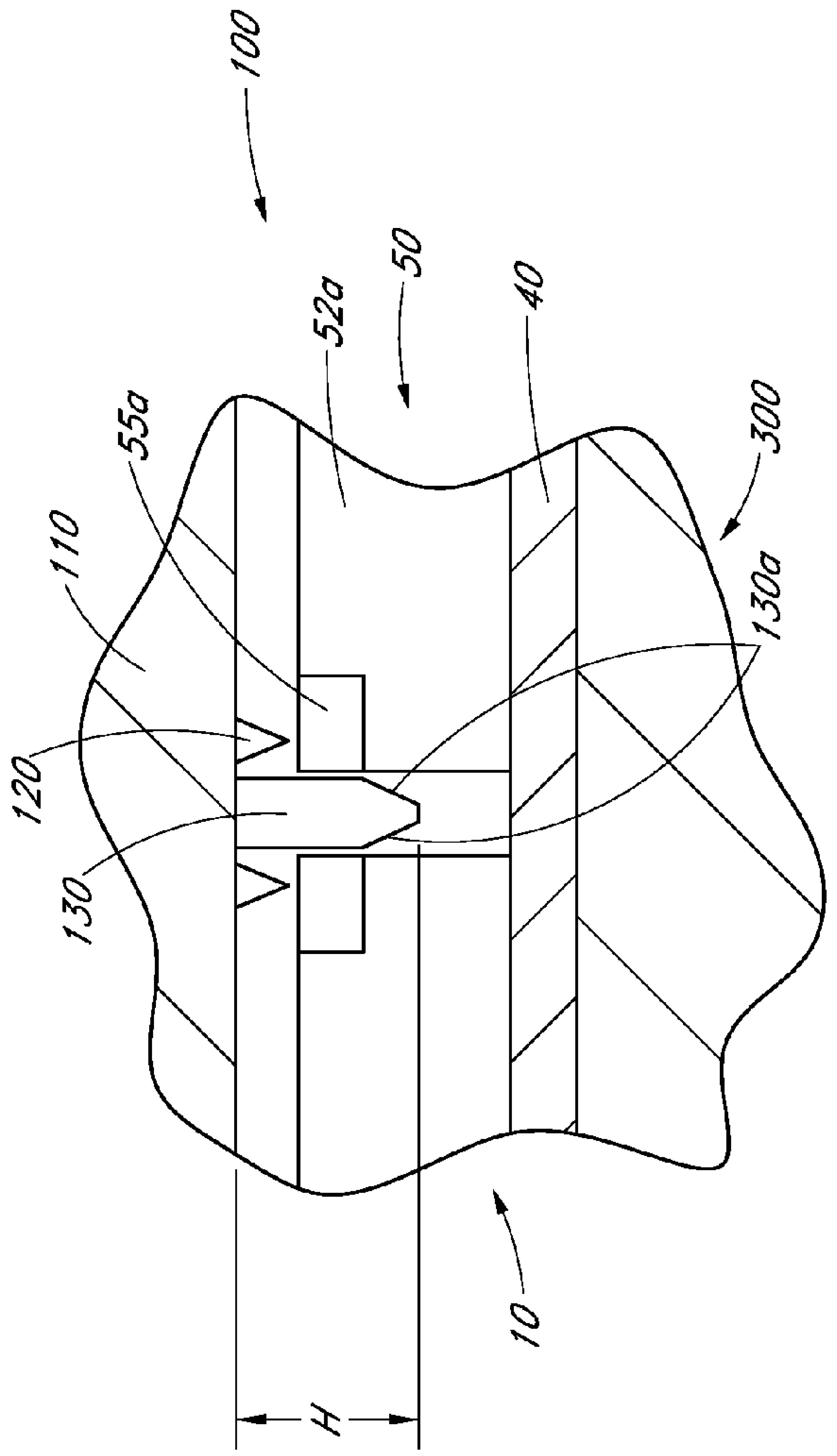

100
52a
50
40
300
55a
110
130a
120
130
10
H

FIG. 8

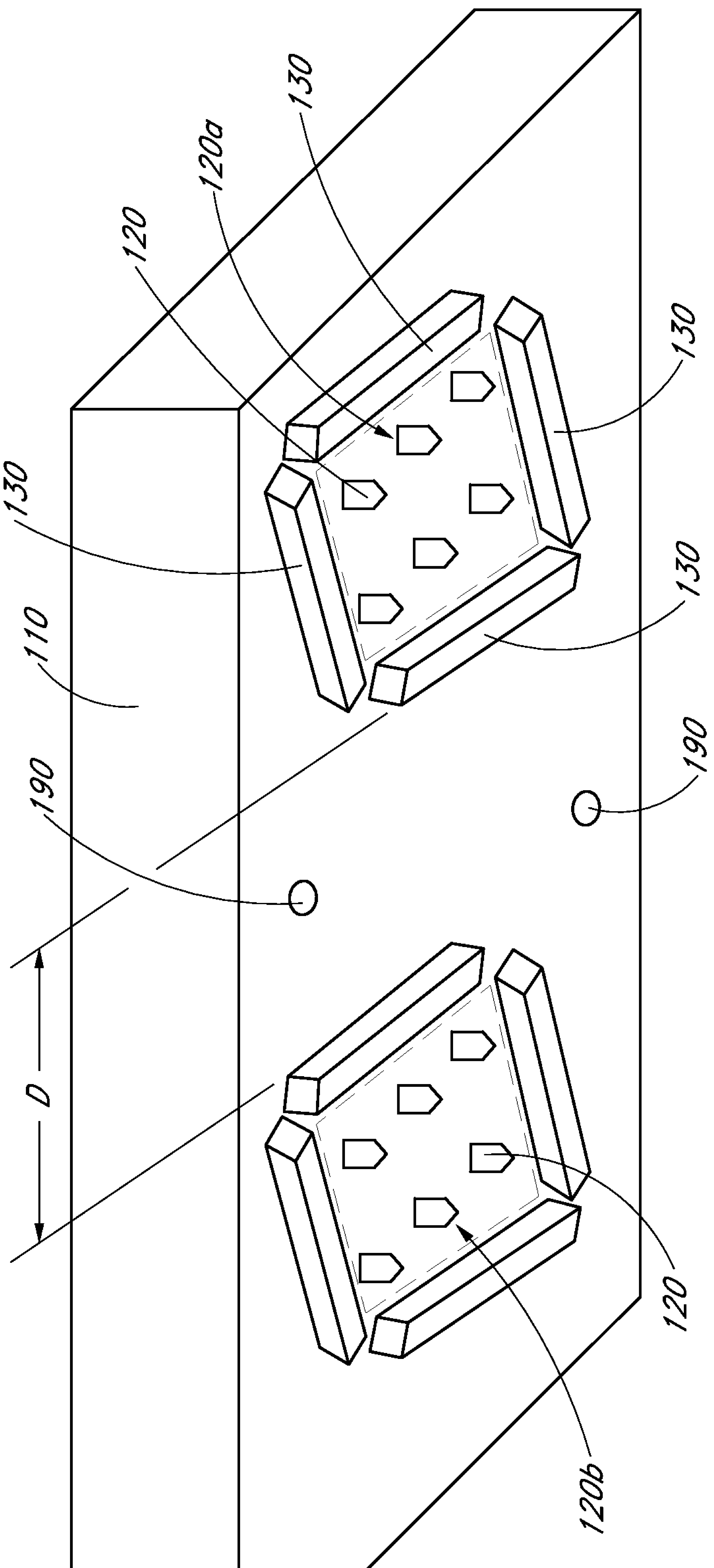



*FIG. 9*

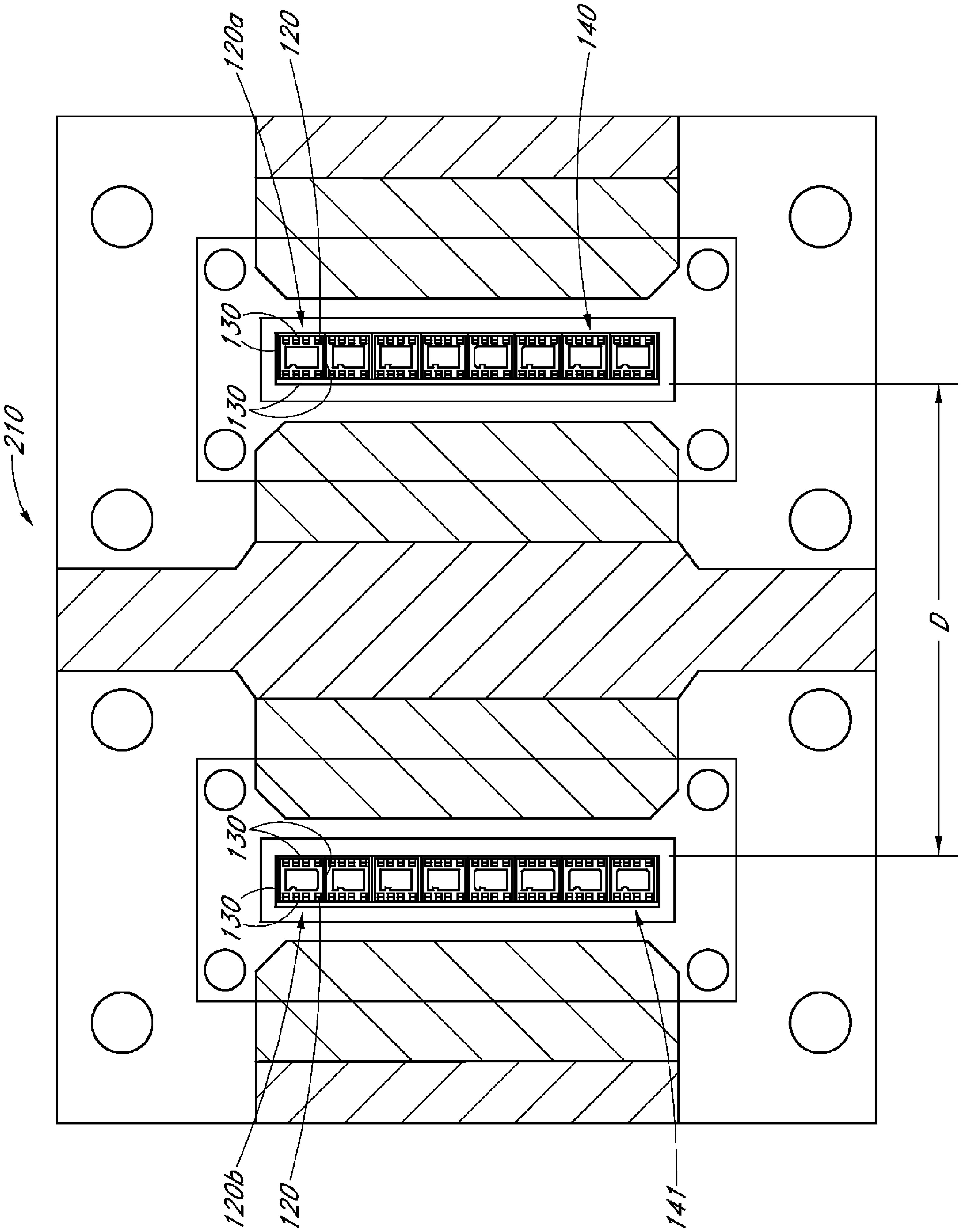



FIG. 10

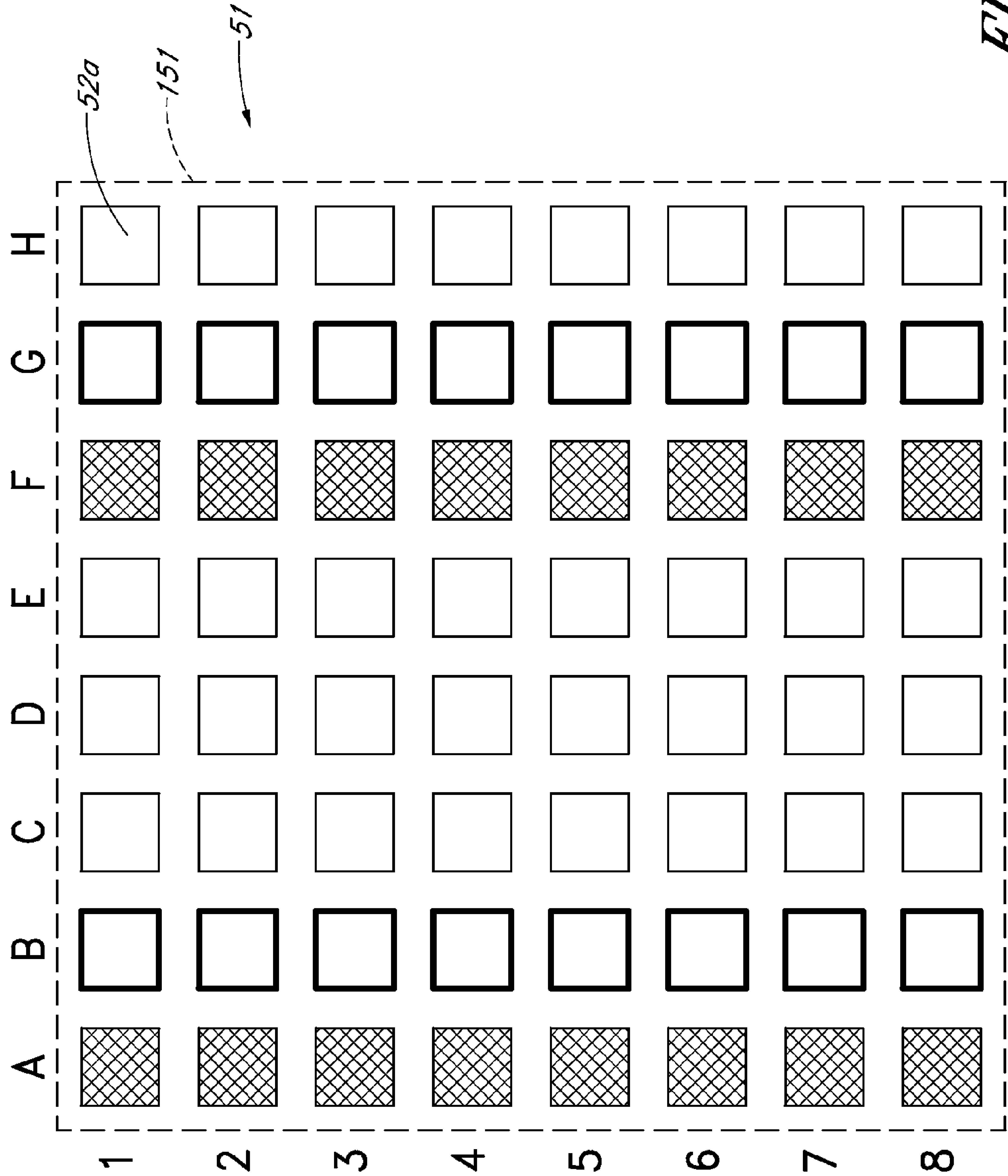



*FIG. 11*

# APPARATUS AND METHOD FOR TESTING MULTIPLE INTEGRATED CIRCUIT DEVICES ON A FILM FRAME HANDLER

## FIELD OF THE INVENTION

The present disclosure relates generally to methods and apparatus for singulating and testing integrated circuit packages.

## DESCRIPTION OF THE RELATED ART

Film frame assemblies are used to carry integrated circuits, dies or chips during the semiconductor packaging and testing process. The integrated circuits are mounted onto a lead frame. Electrical interconnections are formed between the leads and the integrated circuits, using known packaging techniques such as wirebonding (e.g. thermosonic bonding) and flip chip techniques (e.g., controlled collapse chip connection, or C4). The lead frame and mounted chips are then covered with a thin encapsulant, such as epoxy to encapsulate the chips, preventing physical damage or corrosion thereto. A film frame assembly is formed by mounting one or more lead frames on a film or membrane extending across an opening in a film frame or other generally rigid structure. The leads extending between the chips and the lead frame are cut in a saw-singulation process, separating the singulated integrated circuit packages from each other and from the remainder of the lead frame. The film frame assembly can then be used within a semiconductor test device to test the singulated integrated circuit packages. However, movement of the integrated circuit packages on the film frame can interfere with accurate testing.

## SUMMARY

One embodiment provides a method for forming a film frame assembly, comprising providing a film frame including a plastic film for supporting lead frames during singulation and testing. The method further comprises mounting a lead frame on the film, the lead frame comprising an array of integrated circuit packages and a frame portion surrounding the array, wherein a plurality of leads connect the adjacent integrated circuit packages in the array to each other. The method further comprises cutting through the leads to form a singulated integrated circuit package, wherein cutting comprises leaving at least three sides of the frame portion intact such that the at least three sides of the frame portion extend along at least three sides of the array in an unbroken manner.

Another embodiment provides a film frame assembly for testing and singulating integrated circuit packages. The film frame assembly comprises a film frame including a plastic film for supporting lead frames and a lead frame mounted on the film. The lead frame comprises an array of integrated circuit packages, wherein a plurality of the integrated circuit packages are singulated. The lead frame further comprises a frame portion surrounding the array, at least three sides of the frame portion extending unbroken to limit relative movement among the singulated packages.

Another embodiment provides an apparatus for testing a plurality of singulated integrated circuit packages. The apparatus comprises a contactor body configured to be positioned proximate to an array of singulated integrated circuit packages within a lead frame mounted on a film frame assembly. The apparatus further comprises a first set of electrical contacts attached to the contactor body. The first set comprises a first plurality of electrical contacts configured to be able to contact and test a first plurality of leads on a first integrated circuit package. The apparatus further comprises a first guide member positioned on the contactor body, wherein the first guide member is configured to substantially mechanically align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages.



Another embodiment provides a method for testing an array of singulated integrated circuit packages within a lead frame mounted on a film frame assembly. The method comprises providing a contactor body. The method further comprises providing a plurality of sets of electrical contacts attached to the contactor body, each set comprising a plurality of electrical contacts configured to be able to contact and test a plurality of leads on a singulated integrated circuit package within the array. The method further comprises providing a first guide member on the contactor body. The method further comprises moving the contactor body and the array proximate to each other such that the first guide member is positioned between a first singulated integrated circuit package within the array and a second singulated integrated circuit package adjacent to the first singulated integrated circuit package within the array, causing the first guide member to substantially mechanically align a first set of electrical contacts within the plurality of sets of electrical contacts with a first plurality of leads on the first singulated integrated circuit package.

For purposes of summarizing the invention and the advantages achieved over the prior art, certain objects and advantages of the invention have been described above and as further described below. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

All of these embodiments are intended to be within the scope of the invention herein disclosed. These and other embodiments of the present invention will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiments having reference to the attached figures, the invention not being limited to any particular preferred embodiment(s) disclosed.

## BRIEF DESCRIPTION OF THE DRAWINGS

The appended drawings are schematic, not necessarily drawn to scale, and are meant to illustrate and not to limit embodiments of the invention.

FIG. **1** is a top plan view of a film frame assembly.

FIG. **2** is a top plan view of one of the lead frames shown in FIG. **1**.

FIG. **3** is a top plan view of one block of integrated circuits in the lead frame of FIG. **2**.

FIG. **4** is an enlarged view of a section **4-4** of the lead frame of FIG. **3**.

FIG. **5** is a top plan view of partially singulated integrated circuit packages in a film frame assembly, in accordance with one embodiment.

FIG. **6A** is a schematic, enlarged view of a section **6-6** of the lead frame of FIG. **5**.

FIG. **6B** is a top plan view of a singulated integrated circuit package.

FIG. **7** is a schematic, partial side cross-sectional view of an apparatus for testing a plurality of singulated integrated circuit packages in a film frame assembly, in accordance with one embodiment.

FIG. **8** is a close-up view of a section **8-8** of the testing apparatus of FIG. **7**.

FIG. **9** is a schematic bottom, front, isometric view of an embodiment of the contactor body of FIGS. **7-8**.

FIG. **10** is a bottom plan view of an embodiment of a contactor body.

FIG. **11** schematically illustrates a stepping pattern for testing an array of integrated circuit packages.

## DETAILED DESCRIPTION OF THE DRAWINGS

The present disclosure relates generally to packaging equipment for integrated circuit packages, including film frame assemblies and contact bodies for singulating and testing integrated circuit packages, as well as associated methods for forming a film frame assembly, forming contact bodies, and testing and singulating integrated circuit packages. Certain embodiments relate to methods for cutting through a plurality of leads on a lead frame to form a singulated integrated circuit package. Certain embodiments relate to apparatus and methods for mechanically aligning a set of electrical contacts attached to a contactor body with a plurality of leads on a singulated integrated circuit package.

Singulation processes can cut through the entire width, length and thickness of the lead frame to completely sever each chip package from other chip packages and the frame. Because of the elasticity of the plastic membrane of the film frame assembly, the integrated circuit packages can move relative to each other and/or relative to the remainder of the lead frame assembly during the singulation and testing process, causing misalignment between the integrated circuit packages and the test equipment. Such movement and misalignment can be expensive, due to reduced yield, testing accuracy, throughput, etc.

The disclosed embodiments provide methods of forming a film frame assembly, and the resulting structure, without cutting through the entire length and/or width of the lead frame during the singulation process. This reduces the possible range of relative movement among the integrated circuit packages on the film frame during the singulation process and/or during the testing of the singulated integrated circuit packages. The disclosed embodiments also provide apparatus and methods for testing a plurality of integrated circuit packages. A contact body of the testing equipment is provided with at least one guide member configured to substantially mechanically align the contacts on the contact body with leads on an integrated circuit package. These embodiments can be used separately or in combination to increase yield, testing accuracy, throughput, and the like, during the singulation and testing of the integrated circuit packages. It should be understood that the disclosed embodiments present examples for illustrative purposes, and that the scope of the concepts and advantages described herein is not limited to those examples.

FIG. **1** schematically illustrates a a film frame assembly **10** that can be used to carry a plurality of integrated circuit packages during the singulation and testing processes. The film frame assembly **10** can comprise a supporting structure, illustrated as a film frame **20**, to carry one or more lead frame(s) **50**. In some embodiments, an opening **30** can extend through the film frame **20**, with a film **40** extending across the opening **30**. The lead frames **50** can be mounted on the film **40** using any suitable technique, such as adhesive (e.g., pressure-sensitive adhesive). It will be understood that various numbers of lead frames **50** can be mounted on film **40**, although three lead frames **50** are shown in the illustrated embodiment for exemplary purposes.

The film frame **20** can comprise any suitable shapes, sizes, materials and configurations. The film frame **20** can comprise an approximately rectangular, square, ovular, oblong, or other regular or irregular shape, and is illustrated for exemplary purposes as an approximately circular shape. The film frame **20** can comprise any of many different materials with sufficient rigidity to support the film **40** with the lead frame **50** mounted thereon, such as plastic or metal. The opening **30** can be approximately the same or different shape as the film frame **20**, and can extend partially or completely therethrough. In the illustrated embodiment, the opening **30** extends through and is approximately the same shape as the film frame **20**.

The film **40** can be configured to span some, most, or preferably all of the film frame **20** (e.g., to cover the opening **30**). In some embodiments, the film **40** can be stretched under tension across some, most or all of the surface of film frame **20**. The film **40** can be attached to the film frame **20** (or to an intermediate structure) in any suitable fashion, such as with adhesive (e.g., pressure sensitive adhesive) or other bonding techniques. In some embodiments, the film frame **20** can comprise two or more pieces configured to clamp the film **40** therebetween. The film **40** is typically plastic and can comprise, e.g., a thermoplastic polymer. The film **40** can comprise any suitable thickness sufficient to support the lead frames **50** and the individual packages during the singulation and testing of the integrated circuit packages, as described further herein. In a preferred embodiment, the film **40** comprises UV adhesive PVC film and is approximately 0.1 mm to 0.2 mm thick.

FIG. **2** schematically illustrates an embodiment of the lead frame **50**. FIG. **3** is an enlarged view of one block of packages of the lead frame **50** of FIG. **2**. FIG. **4** is an enlarged view of a section of the lead frame **50** of FIG. **3**. Referring to FIGS. **2-4**, the lead frame **50** can comprise one or more blocks or arrays **51** of integrated circuit or chip packages **52** carried by a supporting structure, such as a plastic or resin film. It will be understood that the lead frame **50** can comprise different numbers of arrays **51** aligned on the lead frame **50** in various configurations, and that the four arrays shown extending linearly along lead frame **50** are for illustrative purposes only. Thus, the lead frame **50** can comprise shapes other than the approximately rectangular shape shown, such as approximately square, oblong, or circular shapes.

The lead frame **50** comprises a frame portion **53** surrounding the arrays **51**. The frame portion **53** can be any of a variety of shapes, such as a curved, e.g. approximately circular shape, and can be the same or a different shape relative to the array **51**. In the illustrated embodiment, the frame portion **53** comprises two pairs of opposed sides **53***a* and **53***b* that form an approximately rectangular frame around arrays **51**. A plurality of handling elements **54** can be configured on the frame portion **53** proximate and spaced around the perimeter of the arrays **51**. Handling elements **54** can facilitate the guiding, indexing, movement, and/or otherwise robotically controlling lead frame **50** and/or film frame assembly **10** (FIG. **1**) during the processing of film frame assembly **10**. Handling elements **41** can be controlled, e.g., with a control system **200** (FIG. **7**) and/or one or more sensors **190** (FIG. **9**). Handling elements **54** can extend partially or completely through frame portion **53**, and/or can be marked on or visible through a surface of frame portion **53** using conventional methods.

Each block or array **51** comprises a plurality of integrated circuit packages **52**. The array **51** is shown in FIG. **3** with twenty two integrated circuit packages **52** extending along the length of lead frame **50**, and twenty four integrated circuit packages **52** extending along the width of lead frame **50** for a total of 528 packages **52** per array **51**, but these numbers are for illustrative purposes only. A network of external leads **55** (FIG. **4**) extends between chips of adjacent integrated circuit packages **52**, and between the frame portion **53** and the chips of integrated circuit packages **52** adjacent to the frame portion **53**, prior to singulation.

FIG. **5** is a top plan view of an embodiment of a partial singulation process for the integrated circuit packages **52** mounted on the film frame assembly **10**. FIG. **6**A is an enlarged view of the lead frame **50** of the encircled region **6-6** of FIG. **5**. FIG. **6**B is a top plan view of a singulated integrated circuit package. Referring to FIGS. **5-6**B, the integrated circuit packages **52** can be singulated (e.g., separated from each other) to form singulated integrated circuit packages **52***a* by sawing or otherwise cutting through the lead frame **50**, and in some embodiments, partially into the film **40**, illustrated as cuts **60-63**. The cuts **60-63** are shown in hidden lines for clarity. The cuts **60-63** extend between the integrated circuit packages **52** (e.g., cuts **62-63**), or between the integrated circuit packages **52** and the sides of frame portion **53** (e.g., cuts **60** and **61**). The cuts **60-63** extend through the external leads **55**, to form a plurality of leads **55***a* corresponding to each integrated circuit package **52**. It will be understood that although only cuts **60-63** are shown, additional cuts substantially similar to **60-63** will be used to cut through the remainder of the leads **55***a* in the arrays **51**.

More extensive cuts extending through the width, length, and thickness of the lead frame would separate the frame portion into a plurality of pieces. In the illustrative embodiment, the cuts **60-63** can extend partially across the width (e.g., cuts **61** and **63**) and/or partially across the length (e.g., cuts **60** and **62**) of the lead frame **50**, without cutting through the entire length and/or width of the lead frame **50**. As such, frame portion **53** can be left intact, to form an unbroken perimeter individually or collectively surrounding arrays **51**. By leaving frame portion **53** intact, the movement of the integrated circuit packages **52** relative to each other and relative to frame portion **53** can be reduced, improving the yield, accuracy, alignment, etc., during the singulation and testing processes. Cutting through the frame portion **53** would allow stretching or sagging of the film **40** across the entire film frame assembly **10** (e.g., 300 mm×300 mm) to affect the position of any singulated package **52***a*. In contrast, the illustrated process confines stretching that could affect relative positions of singulated packages to the area within each lead frame **50** (e.g., 246 mm×66 mm).

As shown in FIG. **6**A, the cuts **60** and **62** can stop short of cutting through the entire length of lead frame **50** by a distance W**1** from the end of the side **53***a* of the lead frame **50**. The length of distance W**1** can be selected depending on the amount of rigidity and support desired within frame portion **53**, and the type of materials used within lead frame **50**. In some embodiments, W**1** can range from approximately 0.5 mm to 20 mm, preferably approximately 1 mm to 10 mm, and in the illustrated embodiment is approximately 1 mm to 3 mm.

The cuts **61** and **63** can stop short of cutting through the entire width of lead frame **50** by a distance W**2** from the end of the side **53***b* of lead frame **50**. Distances W**1** and W**2** can be the same or different lengths relative to each other. Distance W**2** can comprise a similar range of distances and can allow frame portion **53** to function substantially similarly to that provided by distance W**1**.

Preferably, at least two opposite sides of the frame portion **53** and one segment connecting the two opposites remain intact. It will by understood that the cuts **60** and **62** can stop short of cutting through the entire length of lead frame **50** from either or both ends of sides **53***a* of the lead frame **50**. Similarly, the cuts **61** and **63** can stop short of cutting through the entire width of lead frame **50** from either or both ends of sides **53***b* of the lead frame **50** (FIG. **5**). In some embodiments, cuts **60** and **62** can stop short of cutting through one side **53***a*, while cutting through the opposite side **53***a* of frame portion **53**. In some embodiments, cuts **61** and **63** can stop short of cutting through one side **53***b*, while cutting through the opposite side **53***b* of frame portion **53**. In a preferred embodiment, cuts **60-63** cut through lead frame **50** to leave at least three sides of frame portion **53** are connected and intact, such that the at least three sides of frame portion **53** extend along at least three sides of arrays **51** in an unbroken manner. Allowing the cuts to extend through one frame portion side **53***a* and **53***b* would expose the packages **53***a* to movement from stretching of the film outside the frame in that direction, but would nevertheless limit movement from the other sides. Relative movement from film stretching is most curtailed by leaving the frame portion **53** uncut on all sides after singulation, such that the unsevered frame portion surrounds the singulated packages **52***a*, as shown in FIG. **5**. The skilled artisan can readily extend the teachings herein to non-rectangular lead frame shapes.

In an exemplary method for forming the film frame assembly **10**, the film frame **20** is provided, and can include a film **40** (e.g., a plastic film) for supporting one or more lead frames **50** during singulation and testing of the integrated circuit packages **52**. The lead frame **50** is mounted on the film **40**. The lead frame **50** comprises one or more array(s) **51** of integrated circuit packages **52** and the frame portion **53** surrounding the array(s) **51**. The plurality of leads **55** can connect the adjacent integrated circuit packages **52** in the array **51** to each other. The leads **55** can be cut through, forming a singulated integrated circuit package **52***a*. In some embodiments, cutting comprises leaving at least three sides (e.g., three of opposed pairs **53***a*, **53***b*) of the frame portion **53** intact such that the at least three sides of the frame portion **53** extend along at least three sides of the array **51** in an unbroken manner. In some embodiments, the cutting step comprises leaving the frame portion **53** intact such that the frame portion **53** forms an unbroken perimeter surrounding the array **51**. In some embodiments, the cutting step comprises leaving the film **40** intact.

FIG. **7** schematically illustrates a partial side cross-sectional view of an embodiment of an apparatus **100** for testing a plurality of singulated integrated circuit packages **52***a*. The testing apparatus **100** can be controlled by a control system **200**, which can include software that controls the apparatus and methods described further herein. FIG. **8** schematically illustrates an enlarged view of the apparatus **100** of encircled section **8-8** of FIG. **7**. Referring to FIGS. **7-8**, the testing apparatus **100** comprises a contactor body **110** configured to be positioned proximate to the array **51** during the testing of the singulated integrated circuit packages **52***a*. The packages **52***a* can be conventionally singulated or singulated by the process of FIGS. **5-6**. A plurality of electrical contacts **120** extend from a surface of the contactor body **110**. The electrical contacts **120** are arranged in sets, sized and spaced to be able to contact and test a plurality of leads **55***a* on the singulated integrated circuit packages **52***a* when the contactor body **110** is positioned proximate to the array **51** of singulated integrated circuit packages **52***a*.

The testing apparatus **100** can comprise a handler plate **300** configured to support and hold film frame assembly **10** and lead frame **50** during the testing of the array **51** of singulated integrated circuit packages **52***a*. The handler plate **300** can comprise any suitable configuration for handlers used in the field of integrated circuit testing equipment. In the illustrated embodiment, handler plate **300** is configured to receive film frames **20**, and supports their films **40** during testing. The handler plate **300** and/or contactor body **110** can move horizontally and/or vertically relative to each other to align and contact the contacts **120** with corresponding leads **55***a* during a testing process.

FIG. **9** is a schematic, bottom front isometric view of an embodiment of the contactor body **110** of FIGS. **7-8**. The electrical contacts **120** can be grouped into one or more sets (e.g., sets **120***a*, **120***b*), wherein each set is configured to contact a set of leads **55***a* on a corresponding integrated circuit package **52***a*. Typically, the contact body includes multiple sets (two shown) in order to simultaneously test multiple singulated integrated circuit packages **52***a* for high throughput.

In some embodiments, the sets **120***a* and **120***b* can be spaced from each other by a distance D. Such spacing can allow additional electronic components or circuitry to be incorporated in the contactor body **110** between sets **120***a* and **120***b*. Such circuitry can provide additional features beneficial to the testing of the integrated circuit packages **52***a* within the array **51**, and/or the control of film frame assembly **10** (e.g., the handling, movement, alignment, etc. of film frame assembly **10**; FIGS. **7-8**). In some embodiments, electrical decoupling circuitry, which often employs large capacitors, is positioned between sets **120***a* and **120***b* to electrically isolate the sets **120***a* and **120***b* from each other, reducing cross-talk or electronic interference between adjacent testing circuitry for packages **52***a* under test during the testing process. Spacing the sets **120***a* and **120***b* from each other can allow the sets **120***a* and **120***b* to simultaneously test, two corresponding singulated integrated circuit packages **52***a* spaced from each other. "Simultaneously test" as used herein refers to the testing while simultaneous contact is made between two sets of contacts and corresponding leads, including a first test on a first integrated circuit package, followed by a second test on a second integrated circuit package, without breaking contact between the first and second test. As described further herein (FIGS. **10** and **11**), the distance D can be selected such that one or more integrated circuits **52***a* can be positioned in the film frame assembly **10** between those integrated circuits **52***a* being tested by the sets **120***a* and **120***b*.

The contactor body **110** can also comprise one or more optical alignment features **190** (e.g., a vision system) to aid the control system **200**, and facilitate the alignment and movement of the contactor body **110** and the handler plate **300** (FIGS. **7-8**) relative to each other. It will be understood that the optical alignment features **190** can be positioned on the contactor body **110** between sets **120***a* and **120***b*, as shown in FIG. **9**, or in other positions on the contactor body **110**. Typically, such optical alignment features **190** work in conjunction with sensors on the handler plate **300** side of the equipment, or vice versa. However, such optical alignment does not obviate misalignment problems that can result from stretching of the film **40**.

Referring to FIGS. **7-9**, the contactor body **110** comprises a guide member **130** positioned on the contactor body **110**. The guide member **130** can be configured to substantially mechanically align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array **51** of singulated integrated circuit packages **52***a*. In some embodiments, the guide member **130** can be sized and shaped to fit between adjacent singulated packages **52***a* of the film frame assembly. In one embodiment, the guide member **130** can fit between adjacent packages separated by a distance between about 0.5 and 5 mm, more particularly, between about 1 mm and 3 mm. In use, as the contactor body **110** is moved towards the handler plate **300**, as shown by arrow **510** (FIG. **7**) and/or as the handler plate **300** is moved towards the contactor body **110**, as shown by arrow **520** (FIG. **7**), if there is slight misalignment, the guide member **130** contacts a portion (e.g., a top edge) of the singulated integrated circuit package **52***a*, guiding the package **52***a* (e.g., horizontally or laterally) into alignment with the set of contacts **120** and allowing the guide member **130** to extend between the singulated integrated circuit package **52***a* and an adjacent integrated circuit package **52***a*. Thus, guide member **130** can align contacts **120** with leads **55***a* on the integrated circuit packages **52***a*, increasing the testing accuracy and increasing yield for the testing process.

The guide member **130** can comprise any of a variety of shapes. Guide member **130** can comprise a pin, rod or sidewall with various cross-sectional shapes (e.g., circular, rectangular, and the like), extending transversely along and/or longitudinally from contactor body **110**. Regardless of shape, the guide member **130** comprises a protrusion extending a height H from a surface of the contactor body **110** (FIG. **8**). The height H is selected to be less than the thickness of singulated integrated circuit package **52***a* to be tested, to prevent guide member **130** from extending beyond the bottom edge of integrated circuit package **52***a* (e.g., and contacting or piercing the film **40**). In some embodiments, the height H is less than 1 mm, and in some embodiments, less than 0.5 mm. In the illustrated embodiment, the guide member **130** includes a chamfered, sloped, curved, or radiused edge **130***a* (FIG. **8**) at its distal end, such that relative vertical movement between the contactor body **110** and the array of singulated packages can be translated into relative horizontal movement upon contact between the chamfered edge **130***a* and the corner of a package **52***a*, allowing the guide member **130** to be inserted between two adjacent integrated circuit packages **52***a*.

The guide members **130** can comprise any suitable material but are preferably electrically insulating. Even conductive materials can be used, although the guide members **130** do not electrically communicate with any circuitry. Elastomeric materials (e.g., rubber) can advantageously minimize risk of damage to packages **52***a* during operation.

The contactor body **110** can be configured with a plurality of guide members **130** positioned to surround each integrated circuit package **52***a* to facilitate the alignment of the contacts **120** with the leads **55***a*. In some embodiments, contactor body **110** can be configured with a plurality of guide members **130** configured to be positioned between (and thus align) a plurality of adjacent singulated integrated circuit packages **52***a* (e.g., a row or a column of singulated integrated circuit packages; FIGS. **7**, **10-11**). While FIG. **9** shows guide members **130** surrounding each contactor set **120***a*, **120***b*, it will be understood that the guide members **130** can be arranged in a grid to surround even packages **52***a* not tested in a particular step, such that a set of guide members **130** may surround a package **52***a* in use but be empty of contacts.

FIG. **10** is a bottom plan view of an embodiment of a contactor body **210** configured with a plurality of sets **120***a* and **120***b* of contacts **120**. The contactor body **210** can be similar to and function substantially similarly to contactor body **110** shown in FIGS. **7-9**. The plurality of sets **120***a* and **120***b* of contacts **120** can be grouped into a first group **140** and a second group **141**, respectively. The first group **140** can be positioned adjacent to the second group **141**, or, as shown in the illustrated embodiment, the first group **140** can be spaced apart from the second group **141** by the distance D.

The groups **140** and **141** can comprise different numbers of sets **120***a*, **120***b* of contacts **120**, respectively, and the groups **140** and **141** can comprise the same or different numbers of sets **120***a*, **120***b* relative to each other. The groups **140** and **141** are each shown with eight sets **120***a*, **120***b* of contacts **120**, for illustrative purposes only. It will also be understood that the plurality of sets **120***a* and **120***b* can be positioned in various manners relative to one another within groups **140** and **141**, respectively, to form various testing patterns and to allow various testing sequences when testing the integrated circuits **52***a* within array **51**. Thus, the groups **140** and **141** are not to be limited to a single row or column of a plurality of adjacent sets **120***a*, **120***b*, respectively of contacts **120**, as shown in FIG. **10**. The groups **140** and **141** can comprise a plurality of sets **120***a*, **120***b* spaced adjacent or apart from each other in a row, column, checkerboard, L-shaped, T-shaped, or other pattern.

FIG. **11** is a top plan view of a portion **151** of the array **51**. The portion **151** of array **51** is shown as a series of squares labeled by row and column to schematically illustrate the positioning of the singulated integrated circuit packages **52***a* on a film frame that can be simultaneously tested using various configurations of groups **140** and **141** (FIG. **10**). For ease of illustration, reference numerals are provided for rows **1-8**, and reference letters for columns A-H. The use of "rows" and "columns" herein does not imply a particular orientation of the portion **151** of the array **51** relative to its positioning on lead frame **50** (FIG. **1**).

Referring to FIGS. **10** and **11**, the portion **151** of the array **51** of singulated integrated circuit packages **52***a* can be tested by moving contactor body **210** and the portion **151** of array **51** mounted on the film frame proximate to each other. One or more guide members **130** can mechanically align the contacts **120** within groups **140** and **141** with the leads **55***a* (FIGS. **6**A-**6**B) corresponding to the singulated integrated circuit packages A**1**-A**8** and F**1**-F**8**. The contactor body **210** and array **51** can be vertically (assuming the orientation of FIGS. **7-8**) relative to each other such that the contacts **120** within groups **140**, **141** are in electrical communication with the integrated circuit packages A**1**-A**8** and F**1**-F**8**, allowing packages A**1**-A**8** and F**1**-F**8** to be simultaneously tested (Test Position **1**). The integrated circuit packages A**1**-A**8** and F**1**-F**8** are shown cross-hatched in FIG. **11** for illustration of the groupings. Next, the contactor body **210** and array **51** can be moved sufficiently away from each other to sever the electrical communication between the packages A**1**-A**8**, F**1**-F**8** and the corresponding contacts **120** within groups **140**, **141** on body **210**, and to withdraw the guide members **130** from between adjacent packages **52***a*. Subsequently, the contactor body **210** and array **51** can be moved (e.g., horizontally stepped or indexed) relative to each other to mechanically align the contacts **120** within groups **140**, **141** with the leads **55***a* (FIGS. **6**A-**6**B) corresponding to the singulated integrated circuit packages B**1**-B**8** and G**1**-G**8**. The contactor body **210** and array **51** can be further moved vertically relative to each other such that the contacts **120** within groups **140**, **141** are in electrical communication with the integrated circuit packages B**1**-B**8** and G**1**-G**8**, allowing packages B**1**-B**8** and G**1**-G**8** to be simultaneously tested (Test Position **2**). The integrated circuit packages B**1**-B**8** and G**1**-G**8** are shown bolded in FIG. **11** for illustration of the groupings. The above steps can be repeated, thus stepping or indexing through the remainder of portion **151** and, in some embodiments, through the remainder of array **51** until the entirety of array **51** is tested. In some embodiments, an optical alignment step can be performed prior to and/or subsequent to the step of moving contactor body **210** and the array **51** relative to each other.

It will be understood that the configurations of group **140** and/or **141** can be selected to correspond to various testing patterns within the portion **151** of array **51**. For example, the distance D between groups **140** and **141** can be selected using the contactor body **210** (FIG. **10**) to simultaneously test other columns with packages A**1**-A**8**, such as columns B**1**-B**8**, C**1**-C**8**, D**1**-D**8**, etc. In some embodiments, groups **140** and **141** can be configured to simultaneously test smaller groups of integrated circuit packages, such as A**1**-A**4** with H**1**-H**4**. In other embodiments, the indexing of contactor body **210** and array **51** relative to each other can be performed in different directions; for example, A**1**-A**4** can be simultaneously tested with C**1**-C**4**, and after indexing, B**2**-B**5** can be simultaneously tested with D**2**-D**5**. In some embodiments, groups **140** and **141** can be spaced apart from each other, and the sets of contacts within groups **140** and **141** can be spaced apart from each other. In such an embodiment, A**3** and A**6** can be simultaneously tested with E**3** and E**6** (Position **1**), and after indexing, A**4** and A**7** can be simultaneously tested with E**4** and E**7** (Position **2**). In some embodiments, groups **140** and/or **141** can comprise a checkerboard pattern, allowing, for example, simultaneous testing of C**2**, C**4**, and C**6**, with D**3** and D**5** (Position **1**), and after indexing, D**2**, D**4** and D**6** with E**3** and E**5**.

Advantageously, both the maintenance of the frame portion **53** during and after saw singulation (FIG. **5**) and the use of guide members **130** between singulated packages **52***a* (FIGS. **7-8**) independently aid alignment of contacts **120** with leads on the packages **52***a*. Thus, either or both features enable good alignment with packages of a film frame assembly **10**, despite the tendency of the film **40** to stretch. Better alignment allows the design choice of more widely separating adjacent contact sets, at least in one dimension, which in turn accommodates decoupling circuitry. In one embodiment, the distance between adjacent contact sets in at least one dimension is chosen to be between about 10 mm and 100 mm. In another embodiment, the distance between adjacent contact sets is chosen to be between about 40 mm and 50 mm. In view of the embodiment shown in FIG. **10**, it will be understood that such separation can be provided in one dimension (e.g., distance D in FIG. **10**), while contactor sets **120***b* of one group **141** can be more closely spaced (e.g., 1-3 mm).

Although certain preferred embodiments and examples have been discussed herein, it will be understood by those skilled in the art that the present invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the invention and obvious modifications and equivalents thereof. In addition, while a number of variations of the invention have been shown and described in detail, other modifications, which are within the scope of this invention, will be readily apparent to those of skill in the art based upon this disclosure. It is also contemplated that various combinations or sub-combinations of the specific features and aspects of the embodiments may be made and still fall within the scope of the invention. Accordingly, it should be understood that various features and aspects of the disclosed embodiments can be combined with or substituted for one another in order to form varying modes of the disclosed invention. Thus, it is intended that the scope of the present invention herein disclosed should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the present disclosure, including the appended claims.

What is claimed is:

1. An apparatus for testing a plurality of singulated integrated circuit packages, comprising:

a contactor body configured to be positioned proximate to an array of singulated integrated circuit packages within a lead frame mounted on a film frame assembly;

a first set of electrical contacts attached to the contactor body, the first set comprising a first plurality of electrical contacts configured to be able to contact and test a first plurality of leads on a first integrated circuit package;

a first guide member positioned on the contactor body, wherein the first guide member is configured to substantially mechanically align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages;

a second set of electrical contacts attached to the contactor body, the second set comprising a second plurality of electrical contacts configured to be able to contact and test a second plurality of leads on a second integrated circuit package; and

a second guide member positioned on the contactor body, wherein the second guide member is configured to substantially mechanically align the second set of electrical contacts with the second plurality of leads when the first set of electrical contacts is aligned with the first plurality of leads.

2. The apparatus of claim **1**, wherein the film frame assembly is configured to support at least one lead frame comprising an array of singulated integrated circuit packages surrounded by a frame member, wherein the singulated integrated circuit packages within the array are separated from each other or are separated from the frame member by a gap.

3. The apparatus of claim **2**, further comprising a handler, the handler configured to move the first electrical contact relative to the first lead.

4. The apparatus of claim **1**, wherein the first guide member comprises a protrusion extending from a surface of the contactor body, the protrusion comprising a free distal end.

5. The apparatus of claim **4**, wherein the first guide member extends less than 1 mm from the surface of the contactor body.

6. The apparatus of claim **4**, wherein the first guide member extends less than 0.5 mm from the surface of the contactor body.

7. The apparatus of claim **1**, wherein the first guide member comprises a chamfered tip to facilitate the substantial mechanical alignment of the first electrical contact with the first lead.

8. The apparatus of claim **1**, wherein the first guide member comprises a plurality of protrusions extending from a surface of the contactor body, the plurality of protrusions comprising a plurality of free distal ends configured to substantially surround a singulated integrated circuit package within the array.

9. The apparatus of claim **1**, wherein the first guide member and the second guide member are spaced apart from each other sufficiently to allow a third integrated circuit package to be positioned between the first and the second integrated circuit packages.

10. The apparatus of claim **9** such that a third plurality of leads on a third integrated circuit package can be positioned between the first and second plurality of leads.

11. The apparatus of claim **9**, wherein the contactor body comprises one or more electronic components positioned between the first guide member and the second guide member that electrically isolate the first set of electrical contacts from the second set of electrical contacts.

12. The apparatus of claim **1**, further comprising an optical alignment system configured to substantially align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages.

13. The apparatus of claim **1**, further comprising a control system with software configured to substantially align the first and second sets of electrical contacts with the first and second pluralities of leads, respectively, and substantially align the first and second sets of electrical contacts with a third plurality of leads on a third integrated circuit package and a fourth plurality of leads on a fourth integrated circuit package, respectively, the third and the fourth plurality of leads spaced apart from the first and the second plurality of leads.

14. An apparatus for testing a plurality of singulated integrated circuit packages, comprising:

a contactor body configured to be positioned proximate to an array of singulated integrated circuit packages within a lead frame mounted on a film frame assembly;

a first set of electrical contacts attached to the contactor body, the first set comprising a first plurality of electrical contacts configured to be able to contact and test a first plurality of leads on a first integrated circuit package; and

a first guide member positioned on the contactor body, wherein the first guide member is configured to substantially mechanically align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages; and

an optical alignment system configured to substantially align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages.

15. The apparatus of claim **14**, wherein the film frame assembly is configured to support at least one lead frame comprising an array of singulated integrated circuit packages surrounded by a frame member, wherein the singulated integrated circuit packages within the array are separated from each other or are separated from the frame member by a gap.

16. The apparatus of claim **14**, wherein the first guide member comprises a chamfered tip to facilitate the substantial mechanical alignment of the first electrical contact with the first lead.

17. The apparatus of claim **14**, wherein the first guide member comprises a plurality of protrusions extending from a surface of the contactor body, the plurality of protrusions comprising a plurality of free distal ends configured to substantially surround a singulated integrated circuit package within the array.

18. The apparatus of claim **14**, wherein the first guide member extends less than 1 mm from the surface of the contactor body.

19. An apparatus for testing a plurality of singulated integrated circuit packages, comprising:

a contactor body configured to be positioned proximate to an array of singulated integrated circuit packages within a lead frame mounted on a film frame assembly;

a first set of electrical contacts attached to the contactor body, the first set comprising a first plurality of electrical contacts configured to be able to contact and test a first plurality of leads on a first integrated circuit package; and

a first guide member positioned on the contactor body, wherein the first guide member is configured to substantially mechanically align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages;

wherein the film frame assembly is configured to support at least one lead frame comprising an array of singulated integrated circuit packages surrounded by a frame member, wherein the singulated integrated circuit packages within the array are separated from each other or are separated from the frame member by a gap.

**20**. The apparatus of claim **19**, wherein the first guide member comprises a plurality of protrusions extending from a surface of the contactor body, the plurality of protrusions comprising a plurality of free distal ends configured to substantially surround a singulated integrated circuit package within the array.

**21**. The apparatus of claim **19**, wherein the first guide member comprises a chamfered tip to facilitate the substantial mechanical alignment of the first electrical contact with the first lead.

**22**. The apparatus of claim **19**, wherein the first guide member extends less than 1 mm from the surface of the contactor body.

**23**. An apparatus for testing a plurality of singulated integrated circuit packages, comprising:

a contactor body configured to be positioned proximate to an array of singulated integrated circuit packages within a lead frame mounted on a film frame assembly;

a first set of electrical contacts attached to the contactor body, the first set comprising a first plurality of electrical contacts configured to be able to contact and test a first plurality of leads on a first integrated circuit package; and

a first guide member positioned on the contactor body, wherein the first guide member is configured to substantially mechanically align the first set of electrical contacts with the first plurality of leads when the contactor body is positioned proximate to the array of integrated circuit packages;

wherein the first guide member comprises a protrusion extending from a surface of the contactor body, the protrusion comprising a free distal end.

**24**. The apparatus of claim **23**, wherein the first guide member comprises a chamfered tip to facilitate the substantial mechanical alignment of the first electrical contact with the first lead.

**25**. The apparatus of claim **23**, wherein the first guide member extends less than 1 mm from the surface of the contactor body.

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